



**MAECTITE® TREATMENT PROCESS
LEAD and other HEAVY METAL FIXATION
TECHNICAL INFORMATION BULLETIN**

**Sevenson Environmental Services, Inc.
2749 Lockport Road
Niagara Falls, New York 14302**

December 1993

November 9, 1994

Mr. Brad Bradley
U.S. EPA Region V
Office of Superfund
77 West Jackson Street
Chicago, IL 60604

RE: NL Superfund Site, Granite City, IL

Dear Mr. Bradley,

Thank you for talking with me last week regarding the Granite City Site. As I had indicated in our conversation, Sevenson owns and implements a proprietary and patented process called MAECTITE® which chemically fixates lead and other RCRA metals in a variety of waste matrices. I have attached technical literature regarding our process for your review and consideration when re-evaluating alternatives at this site.

The MAECTITE® process has been applied full-scale at numerous Superfund, RCRA, and voluntary remedial actions. To date, nearly 300,000 tons of RCRA metal contaminated waste has been treated. We have not located a lead contaminated matrix resistant to MAECTITE® treatment. The process has been accepted into the USEPA SITE program and the USEPA Pre-qualified Offerors Procurement Strategy (PQOPS) FSS program.

The MAECTITE® process is cost effective and proven. The process is not cementitious, pozzolanic, and does not produce monolithic structure (i.e. macroencapsulation) post-treatment. Post-treated material will not increase in volume and exhibits minimal or no increase in mass. One of the attached documents presents Multiple Extraction Procedure (MEP) data for a recent treatment project containing materials very similar in nature to the waste pile at the Granite City Site. Since the MAECTITE® process utilizes a liquid reagent mixed with water, effective dust suppression is accomplished during treatment. Sevenson has successfully integrated the MAECTITE® technology into one of the most experience and successful remediation companies in the country, a company that traces it's allied arts to 1917.

Sevenson's wholly owned subsidiary, Waste Stream Technology, operates a licensed analytical laboratory and treatability lab in Buffalo, NY. Upon receipt of a sample, Sevenson could return results of Bench or Engineering treatability testing using the MAECTITE® process in 2-4 weeks.

Mr. Brad Bradley
November 9, 1994
Page 2

I trust the attached literature is sufficient for your needs at this time. Severson is readily available to meet and discuss the MAECTITE® technology with you at your convenience. Please contact me at (812) 988-9930 to arrange a meeting. Thank you for your consideration.

Sincerely,
Severson Environmental Services, Inc.



Charles McPheeters
Project Coordinator

encl/ MAECTITE® Technical Bulletin, Purdue Paper, 1993 Annual Report, MEP Data
cc: Mr. Gene Liu, ACOE, Omaha, NE
Mr. P. DeLuca, SES, Niagara Falls





**MAECTITE® TREATMENT PROCESS
LEAD and other HEAVY METAL FIXATION
TECHNICAL INFORMATION BULLETIN**

**Sevenson Environmental Services, Inc.
2749 Lockport Road
Niagara Falls, New York 14302**

December 1993



TABLE OF CONTENTS

I.	INTRODUCTION
II.	PROCESS DESCRIPTION AND APPLICATIONS
III.	PERFORMANCE DATA
IV.	SELECTED PROJECT SUMMARIES
V.	TREATABILITY STUDY PROCESS
VI.	PRICING
VII.	REFERENCES
VIII.	FORMS
	<ul style="list-style-type: none">● Treatability Study Request● Chain-of-Custody



I. INTRODUCTION

INTRODUCTION

Sevenson has conducted all phases of lead and cadmium fixation, from the initial viability study through detailed work plans to full-scale implementation. Sevenson has successfully treated lead contamination on small, relatively uncomplicated sites, and has successfully demonstrated lead and cadmium fixation on the very largest and most complex sites. Sevenson's success in treating lead-contaminated wastes is attributable to the patented MAECTITE® treatment process. Other metals and compounds that are successfully rendered non-hazardous by RCRA definition with MAECTITE® technology include cadmium, selenium, and barium. Additional target species are copper, nickel, zinc, cyanide, and sulfide.

In the 100,000 tons of lead- and cadmium-contaminated soil and waste that have been chemically fixed to date by the MAECTITE® process (at 13 sites, among them 4 Superfund sites), and in over 100 bench- and engineering-scale treatability studies, not a single lead- or cadmium-bearing soil or solid waste has proven resistant to treatment. The process may be used to treat lead-contaminated sludges or aqueous wastes from the manufacture and use of batteries, paints, pigments, leaded glass, tetraethyl lead, photographic materials, wastes from primary and secondary lead smelting operations, and lead-contaminated wastes from foundries. Lead contamination has been remediated in a variety of matrix types, including gravelly sandy soil, clay, red soils, ash, foundry sand, and sediments or sludges. All lead- and cadmium-contaminated waste materials and debris that fail TCLP criteria for lead have proven responsive to the MAECTITE® treatment process.

The product of MAECTITE® treatment is a non-hazardous material with the appearance of soil, but with up to 36.4 percent reduction in volume with minimal increase in mass (at full-scale production level). The product may be landfilled as a special waste. Since decontamination wastewaters are used to dilute the proprietary reagent, no byproducts or sidestreams are generated.

Other leachable metals (such as selenium, barium, copper, nickel, and zinc) have also been effectively treated by the process, even when not the primary contaminant.

Sevenson also owns and provides the patent-pending CHROMTITE™ technology for soil, sludges, and solid and aqueous waste contaminated with chromium (hexavalent species included). CHROMTITE™ technology is applicable to most multivalent metal species, such as arsenic and mercury.

The MAECTITE® process was accepted into the USEPA Superfund Innovative Technology Evaluation (SITE) program in 1991. In 1991 it was also nominated for the President's Environment and Conservation Challenge Award. That same year the MAECTITE® process was selected by USEPA as one of nine technologies for inclusion in the US/German Bilateral Agreement, a technology demonstration and information exchange.

As a technology approved under USEPA's Pre-Qualified Offers Procurement System (PQOPS), the MAECTITE® treatment process is available to project coordinators and emergency response teams without the need for technical evaluation. The process was patented in March 1993.



II. PROCESS DESCRIPTION AND APPLICATIONS



PROCESS DESCRIPTION

The two-step MAECTITE® process converts leachable lead into mineral crystal species, greatly lowering the solubility of the lead in this complexed form, while typically resulting in a volume reduction. In the first step a proprietary powdered chemical may be blended with the lead-contaminated material. In the second step a proprietary liquid reagent (MAEPRIC) is blended into this mixture. Under standard conditions of temperature and pressure, curing takes 3 to 5 hours. The end product has consistently passed USEPA's Paint Filter test, and has met TCLP criteria for lead as well as criteria associated with other test procedures. These include procedures approved by USEPA (EP Tox and Multiple Extraction Procedure) and other procedures, such as the California Wet Test (Citric Acid Leach) and the Sonication/Extraction Procedure.

The principal behind the MAECTITE® technology is chemical bonding rather than physical binding mechanisms. The MAECTITE® process incorporates chemical bonding to create substituted mixed mineral forms, stable and resistant to leaching, as proven in various leaching tests. Traditional and generally accepted testing procedures focusing on geophysical or geotechnical methods are not applicable to material treated by MAECTITE®.

In mixtures, where physical binding forces entrap, encapsulate, or immobilize heavy metals, geotechnical limits must be examined. If tests are failed, the stabilized metal species are subject to leaching from exposed surfaces created by the condition applied.

Material treated by MAECTITE®, however, contains the metal species as a mineral within the waste matrix. These minerals cannot be degraded by physical forces or by chemical conditions present within landfills or associated with acid rain. MAECTITE®'s stability has been supported by exposing MAECTITE®-treated material (containing metallic-complexed mixed mineral forms) to: (1) intensive and prolonged ultrasonic energy as a leaching force with multiple acidic extractions that simulate 100-year acid rain; (2) electron microscopy assay results; and (3)

TCLP, EP Tox, and ANS 16.1 leaching test methods.

Material treated by the MAECTITE® process resembles untreated material. It is not monolithic, complies with the Paint Filter test free liquid limits, and is easily handled by standard earthmoving equipment. If, in the very unlikely event that a treatment failure is identified, retreatment of material is readily accomplished without material sizing or volume increase.

APPLICATIONS

The MAECTITE® process may be used alone or incorporated into a train of processes that treat organics or other metals. Among the types of material successfully treated by this technology are:

- | | |
|---|---|
| <input type="checkbox"/> Soils-clay, sand, gravel, | <input type="checkbox"/> Battery casings |
| silt and various mixtures, | <input type="checkbox"/> Wire chop & insulation fluff |
| thereof | <input type="checkbox"/> Paint chips |
| <input type="checkbox"/> Sediments | <input type="checkbox"/> Construction debris and other |
| <input type="checkbox"/> Peat | oversized material |
| <input type="checkbox"/> Sludges | <input type="checkbox"/> Aqueous waste streams |
| <input type="checkbox"/> Filter and centrifuge cake | <input type="checkbox"/> Glass (coated and impregnated) |

Although in-situ treatment has appeared feasible at some sites, the most common application of the MAECTITE® process is ex-situ. Ex-situ treatment allows for greater process control, leading to a higher certainty of compliance with project-specific treatment objectives. The method has been successfully applied to wastes amounting to only a few drums up to production rates in excess of 1,400 tons per day. The system may be modified to comply with RCRA regulations on closed/contained and tank treatment systems.



Although the cost of MAECTITE® treatment is low to moderate, cost-effectiveness will depend on a number of site-specific factors. These include:

- Waste characteristics
- Physical handling characteristics of contaminated material
- Treatment system sizing
- Ease of site access
- Transportation and disposal costs for treated material
- Site support requirements
- Waste quantities (economy of scale)
- Ancillary site tasks additional to treatment

Provided that analytical capabilities permit modification of operating variables, MAECTITE® technology works well in fixed-facility installations such as TSD facilities with continuous incoming waste streams, and large-scale site remediation projects. Key benefits are volume reduction and compliance with USEPA land-ban regulations (the MAECTITE® product being disposable as a non-hazardous waste). The MAECTITE® process invariably results in:

- A reduced volume of waste that is decharacterized and delistable
- Minimal increase in waste mass
- Reduced fugitive lead migration
- Reduced costs for waste handling, transportation, and disposal
- Low to moderate cost, due to reduced remedial process time

The MAECTITE® treatment process has been successfully applied to lead- and cadmium-contaminated solid waste on a number of full-scale projects. It is available for immediate implementation on a full spectrum of metals-contaminated sites and waste.



III. PERFORMANCE DATA



PERFORMANCE DATA

Bench/Engineering-Scale Application

Total Projects Completed	100+
Range of Total Lead Treated	1,356 mg/kg to 30 percent
Range of EP Tox/TCLP Lead	> 5 mg/l to 5,000 mg/l (untreated)
Volume Reduction	Up to 54 percent

All treatability studies resulted in successful treatment to USEPA objectives (i.e., to EP Tox standards prior to 1990 and to TCLP standards in or after 1990). Material was also successfully treated to standards of the Multiple Extraction Procedure (MEP), California Wet Test (Citric Acid Leach), and modified Sonication/Extraction Procedure.

Lead-contaminated waste types studied have included soil (clay, loam, sandy loam, loamy sand, peat and organic soils, clayey sand, sand-gravel, and other mixed soil materials); soil with battery casings; soil with lead oxide; ash; filter press cake solids; industrial wastewater treatment plant clarifier sludge; industrial wastewater treatment plant mixed liquors and slurries; centrifuge cake; lead shot; rifle-range sand with lead projectiles; lead-bearing paint chips; and wire cable chop and insulation fluff.

Full-Scale Application

Total Projects Completed	13, with one in progress
Range of Total Lead Treated	200 mg/kg to 29.9 percent
Range of EP Tox/TCLP Lead	> 5 mg/l to 8,000 mg/l (untreated)
Volume Reduction	Up to 36.4 percent

All 13 full-scale application projects resulted in conformance with applicable site cleanup criteria. Lead- and cadmium-contaminated wastes treated at full scale by the MAECTITE® process covered the same broad range of soils and solid waste materials treated by Severson at bench and engineering scale on a number of sites.

See Tables 1 and 2 for general performance data summaries and treatment results.



TABLE 1
TREATMENT RESULTS BY WASTE TYPE
MAECTITE® TREATMENT PROCESS

LEAD

WASTE TYPE (MATRIX)	TOTAL LEAD %	LEACHABLE LEAD (mg/l)	
		BEFORE TREATMENT	AFTER TREATMENT
Sandy loam	2.2	163.7	1.5
Lead birdshot	16.1	3,720	ND
Lead buckshot	11.4	1,705	ND
Clayey slag	14.6	91.8	ND
Slag-lead smelter	6.6	21.3	2.0
Topsoil	15.8	44.5	1.4
	14.6	91.8	ND
	0.344	83.5	0.5
Silty sand/debris	0.56	34.6	ND
Battery casings	0.6 - 12	288	0.6
	2.0	160	0.3
Organic humus soil	0.31 - 1.9	23.2	ND
Silty sand	4 - 5	687	0.7
Solid waste	1.1	9.7	0.01
	0.4	72.4	3.4
Sludge-industrial waste	2.2	59.3	1.6
Filter cake	2.9	245.3	1.1
Gravel	0.16	7.5	0.5
Road gravel	0.34	46	ND
Gray clay	2.2	495	0.2
Grayish brown ash	9.5	520	0.3

TABLE 1 (continued)

WASTE TYPE (MATRIX)	TOTAL LEAD %	LEACHABLE LEAD (mg/l)	
		BEFORE TREATMENT	AFTER TREATMENT
Brown soil-gravel clay	1.37	263	2.1
Brown soil-gravel sand	3.97	303	1.6
Soil with PbO	29.9	3,659	ND
Clarifier sludge	0.85	57.1	0.3
RCRA organic sludge	9.4	580	ND
Carbon with lead dross	12.6	105.6	0.5
Foundry sand with bentonite	1.96	461.2	ND
Wire fluff	0.33 - 0.134	15.9 - 130	0.7
Wire chip	0.3 - 0.7	28	1.9

CADMIUM

WASTE TYPE (MATRIX)	TOTAL CADMIUM %	LEACHABLE CADMIUM (mg/l)	
		BEFORE TREATMENT	AFTER TREATMENT
EF Cove Material	1.3552	198	BDL
Vault Sediment	0.25-14.68	121.3 - 180.2	<1
Marsh Sediment	0.101	108.8 - 125.2	BDL
Marsh Cinders	0.0168	2.12	ND
Marsh Material	0.0184	9.07	ND

NOTE:

- ND = Not Detected (i.e., <0.5 mg/l)
- BDL = Below Detection Limit (i.e. <0.1 mg/l)
- Listed results from bench-, engineering-, and full-scale application
- All analytical procedures performed in accordance with SW-846 (USEPA)
- TCLP results presented except where otherwise listed



TABLE 2
PERFORMANCE DATA
MAECTITE® TREATMENT PROCESS
FULL-SCALE APPLICATION

LEAD

PROJECT NAME AND LOCATION	MATERIAL QUANTITY	TOTAL LEAD	UNTREATED LEACHABLE LEAD TCLP (mg/l)	TREATED LEACHABLE LEAD TCLP (mg/l)	VOLUME RED. %	WASTE TYPE
Confidential Telecommunications Company South East, Texas	4,800 cy	0.1 - 0.33	up to 69.1	<1.1	Not Determined	Wire insulation fluff
Confidential Metal Reclaimer Cleveland, Ohio	1,500 tons	0.4 - 2.85	38.3 - 99.6	0.7	Not Determined	Surface soil with metal debris
Stout Battery Muncie, Indiana	3,850 cy	0.1-29.9	20-3,659 ⁽¹⁾	0.1- <5 ⁽¹⁾	36.4	Clay/sandy silt/debris
Confidential Battery Manufacturer Frankfort, Indiana	387 drums	0.85-2.9	57.1-245.3 ⁽¹⁾	0.27 ⁽¹⁾	Not Determined	Wastewater/sludge filter cake
Lee Farm Woodville, Wisconsin	11,000 tons	2.03-3.55	up to 422.4	0.1- <5	22.1	Clay/sand & gravel casings/debris
Gratiot Iron & Steel Ithaca, Michigan	1,650 tons	3.4	up to 83.5	ND	15.4	Silty sand, clay, debris
Confidential Tool Manufacturer RCRA Closure Eastern Ohio	18,000 tons	1.35-2.28	13.6-710.5	ND	≈ 16-20	Soil/debris/sdmnt grinding wheels foundry sand
Ohio Department of Transportation Emergency Response Muskingum County, Ohio	2,000 tons	1.0	20	<1	≈ 15	Loam with silt, clay, sand, & gravel
Confidential Superfund Site Eastern Virginia	20 tons	1.96	461.2	ND	Not Determined	Surface soil
Traub Battery Sioux Falls, South Dakota	4,500 tons	2.0	8.3-85	ND	Not Determined	Moist, heavy clay, some sand, gravel, battery casing parts, vegetation
Confidential Client Central Michigan	48 drums	Not Available	221	1.3	Not Determined	Soil with lead, projectiles (shooting range)
Confidential Casting Company Northern Michigan	11,000 tons	0.37	9.9	ND	Not Determined	Sludge & spent foundry sand with bentonite binders

TABLE 2 (Continued)

CADMIUM

PROJECT NAME AND LOCATION	MATERIAL QUANTITY	TOTAL CADMIUM %	UNTREATED LEACHABLE CADMIUM TCLP (mg/l)	TREATED LEACHABLE CADMIUM TCLP (mg/l)	VOLUME RED. %	WASTE TYPE
Marathon Battery Cold Spring, NY	40,000 tons treated	.017 to 14.7	2.1 to 198	BDL	Not Available	Marsh sediments- silty clay with high humus content; silty, sandy river bed material; soil, debris and g

NOTE:

BDL = Below Detection Limits (i.e., <0.1 mg/l)

ND = Not Detected (i.e., <0.5 mg/l)

TCLP (USEPA SW 846) results listed unless otherwise indicated

(1) EP Tox (pre-TCLP)



IV. SELECTED PROJECT SUMMARIES



TREATABILITY STUDIES



SELECTED PROJECT SUMMARIES

Treatability Studies

To determine the feasibility of employing the MAECTITE® treatment process at a given site, as well as to estimate costs associated with full-scale treatment, Severson maintains a fully operational treatability laboratory. Testing is carried out in this laboratory at whatever scale suits the purpose, from simple bench-scale studies to assess treatability up to engineering-scale batch treatment to estimate the cost of a full-scale project.

Over 100 treatability studies have been completed to date. Matrices tested have been so widely varied as to include virtually any matrix type likely to occur at full scale. **Thus far the MAECTITE® treatment process has successfully treated every matrix encountered both at bench and engineering scale.**

Selected treatability studies completed by Severson are described in the following pages and listed below.

SITE NAME	LOCATION
Confidential Plumbing Foundry	Salem, Ohio
Confidential Plumbing Manufacturer	Marysville, Ohio
Lee Farm	Woodville, Wisconsin
Lee Farm	Woodville, Wisconsin
Confidential Battery Manufacturer	Frankfort, Indiana
RCRA Closure	Ohio
Gratiot Iron & Steel	Ithaca, Michigan
Portsmouth Naval Shipyard	Portsmouth, New Hampshire
Confidential Tool Manufacturer	Northeastern U.S.
Confidential Gray Iron Foundry	Michigan

SITE NAME	LOCATION
Traub Battery	Sioux Falls, South Dakota
Stout Battery	Muncie, Indiana
Confidential Telecommunications Company	South East, Texas
Confidential Metal Recovery Facility	Cleveland, Ohio



Treatability Study No. 1: Lead in Foundry Sands

Confidential Client, Salem, Ohio

Period of Performance: February - April 1989

A manufacturer of plumbing fixtures owning a number of sites requiring cleanup requested treatability studies to address lead-contaminated soils and debris in the RCRA closure of a 12-acre landfill.

A treatability study was designed to screen 12 different treatment chemicals from six vendors for capacity to fix lead in a solid waste matrix. The waste sample contained EP Tox lead ranging from 8.4 ppm to 11 ppm; pH range was 7.5 to 10.3. The objective of the treatability study was to ascertain what dosage of treatment chemicals would reduce EP Tox lead to levels below 5 mg/l, and at the same time limit waste volume increase to 25 percent or less.

Of the 12 treatment processes tested, only MAECTITE® lowered leachable lead to levels below the regulatory criterion of 5 mg/l. Moreover, even when the waste mass increased by 5 percent, waste volume showed no increase.

The closure plan for this site was revised on the basis of these results.

Treatability Study No. 2: Lead and Selenium in Foundry Sands

Confidential Client, Marysville, Ohio

Period of Performance: February - April 1989

A manufacturer of ceramic plumbing fixtures with a number of sites requiring cleanup requested treatability studies to address lead- and selenium-contaminated soil and debris in the planned RCRA closure of a landfill.

A treatability study was initiated using 12 treatment chemicals from six vendors. Waste samples obtained from the site contained EP Tox selenium and EP Tox lead ranging from 16.9 mg/l to 72.4 mg/l. pH ranged from 7.8 to 8.4.

Of the 12 treatment chemicals tested, only the MAECTITE® powder reduced leachable lead and selenium to levels below the regulatory threshold. Despite an increase in waste mass of 15 percent as a result of amendment with treatment chemicals, waste volume showed no increase. The closure plan was revised on the basis of these results.



Treatability Study No. 3: Lead Fixation in Brown Soil and Black Battery Casing Ash
Lee Farm Site, Woodville, Wisconsin
Period of Performance: March - April 1990

Treatability studies at this 10-acre uncontrolled battery dump site (including a waste-filled quarry) were performed at the request of USEPA Region V. USEPA considered the site to be an imminent danger to human health and the environment.

Two representative samples from the site were processed through Steps I and II of the MAECTITE® procedure. One of the hazardous waste samples was a brown soil with a pH of 7.2 and a TCLP lead level of 316 mg/l. Application of the MAECTITE® treatment process reduced the TCLP lead level in this sample to 2.06 mg/l and sample volume by approximately 22 percent.

The second hazardous waste sample was a black battery casing ash material with a pH of 8.4 and TCLP lead level of 1,880 mg/l. The MAECTITE® treatment process lowered TCLP lead in the material to 0.32 mg/l. [For comparison, a sample of clean potting soil exhibited TCLP lead of 0.1 mg/l and total lead of 14 mg/kg.] The volume of this sample was reduced by 50 percent as a result of MAECTITE® treatment. Curing time was approximately 5 hours.

Refer to Full-Scale Project No. 6 for an implementation summary.

Treatability Study No. 4: Lead Fixation in Soil and Solid-Waste Matrix

Lee Farm Site, Woodville, Wisconsin

Period of Performance: June - August 1990

At the same site described in Treatability Study No. 3, additional studies were undertaken. The purpose of these additional studies was to optimize treatment dosages for full-scale implementation, and to evaluate a less costly grade of MAEPRIC reagent. Two representative samples of lead-containing waste material were obtained.

By employing MAECTITE® powder during Step I and MAEPRIC reagent during Step II, TCLP lead was reduced from 303 mg/l to 1.6 mg/l.

By optimizing reagent dosages as well as validating the effectiveness of a less costly grade of reagent, treatment cost savings of 30 percent were realized. Refer to Full-Scale Project Description No. 6 for an implementation summary.



Treatability Study No. 5: Lead Fixation in Soils, Sludges, and Slurries

Confidential Client, Frankfort, Indiana

Period of Performance: April - May 1990

A battery manufacturer with multiple hazardous lead-waste streams requested MAECTITE® treatability studies to determine the feasibility of decharacterizing these waste streams employing the MAECTITE® treatment process.

To demonstrate application of the MAECTITE® treatment process and to assess the effectiveness of lead fixation/stabilization in various waste matrices, treatability studies were designed and implemented on the following lead-containing waste materials:

- Waste cake with 0.3 percent to 2.86 percent total lead and 57.2 mg/l to 245.3 mg/l EP Tox lead
- Waste slurry with 245.3 mg/l EP Tox lead
- Waste sludge with 2.9 percent total lead and 98.4 mg/l EP Tox lead
- Contaminated soils with 2.1922 percent total lead and 7.5 to 59.3 mg/l EP Tox lead

TCLP lead was reduced to 0.4 mg/l in waste slurry and sludge. In all waste types screened and tested for lead fixation and stabilization, the MAECTITE® treatment process reduced TCLP lead to levels below the regulatory threshold of 5 mg/l.

These treatability studies and others demonstrate that the MAECTITE® treatment process is applicable to a wide variety of lead-contaminated waste materials.

Refer to Full-Scale Project No. 5 for an implementation summary.

Treatability Study No. 6: RCRA Lagoon and Landfill Closure

Lead Fixation in Foundry Wastes

Confidential Client, Ohio

Period of Performance: October - November 1990

This treatability study was performed at the request of the owner of a 150-year old tile-manufacturing facility. An assessment of the 18-acre site showed more than 65,000 tons of lead-contaminated soil and sediment in a 10-acre landfill and a 3-acre lagoon.

Treatability studies were performed on solid waste samples to demonstrate that the MAECTITE® treatment process would fix and stabilize TCLP lead below the regulatory threshold of 5 mg/l. The solid wastes contained total lead ranging from 1,356 mg/kg to 14,420 mg/kg and TCLP lead from 6.4 mg/l to 542 mg/l.

Application of the MAECTITE® treatment process reduced TCLP lead to levels between 0.1 and 2.4 mg/l within 5 hours. The amount of treatment chemical needed for the MAECTITE® treatment process was optimized by means of several lab-scale test runs. The most cost-effective dosage of treatment chemical was then chosen for pricing design of a full-scale treatment system.

Refer to Full-Scale Project No. 8 for an implementation summary.



Treatability Study No. 7: Lead Fixation in Soil and Solid-Waste Matrix

Gratiot Iron and Metal, Ithaca, Michigan

Period of Performance: March - April 1991

Following a preliminary assessment by USEPA Region V, the USEPA contractor requested treatability studies to determine the feasibility of the MAECTITE® process for cleanup of this abandoned 20-acre battery reclamation facility. A removal action was slated at this site on the grounds of imminent endangerment of human health and the environment.

Treatability studies were designed and executed to test the bench-scale application of the MAECTITE® treatment process in fixation and stabilization of lead in solid waste samples. The solid waste composite sample chosen for treatment exhibited a pH of 8.5 with an alkalinity of 5,200 mg/kg, total organic carbon of 0.263 percent, total lead of 3.44 percent, and cation exchange capacity of 23.3 me/100 g. A TCLP metals screen on the untreated sample showed a TCLP lead level of 83.5 mg/l.

Results of initial treatability studies showed that the MAECTITE® treatment process reduced TCLP lead from 83.5 mg/l to 0.5 mg/l in 5 hours curing at a 22 percent moisture level. Optimization of the MAECTITE® treatment process allowed for effective cost pricing on a competitive bid submittal to the client. The MAECTITE® treatment process resulted in a decrease in waste volume of more than 15 percent in all test runs.

A comparison of the MAECTITE® treatment process with cementation technology suggested that under similar moisture conditions the latter did not consistently meet the TCLP regulatory threshold and actually resulted in an increase in waste volume of up to 55.1 percent, depending on the rate of application of Portland cement.

A cost-benefit and technical analysis of the full-scale treatment process and system, including offsite disposal, revealed that MAECTITE® application in lead fixation was more cost-effective and reliable over the long term than Portland-cement-based technologies.

Refer to Full-Scale Project No. 7 for an implementation summary.

Treatability Study No. 8: Lead-Bearing Soils and Sediments

Portsmouth Naval Shipyard, Portsmouth, New Hampshire

Period of Performance: February 1991 - April 1992

Treatability studies were requested for a RCRA corrective action at this submarine-battery storage facility located in a zone of tidal influence.

The objectives of this study were: (1) to test the feasibility of the MAECTITE® treatment process in fixation of leachable lead in the sample collected; and (2) to optimize the amount of treatment chemical needed for fixation of TCLP lead to levels below 5 mg/l. A 5-gallon pail of dark gray to black sample, known to be lead-contaminated, was used for the bench-scale treatability test.

On initial characterization the sample showed a pH of 5.2 (1:2 waste/water suspension), total lead of 1.3 to 2.0 percent, and TCLP lead of 380 to 461 mg/l. The cation exchange capacity of the waste material and the percent of organic carbon were both low, nearly 48 me/100 g and approximately 0.04 percent, respectively. The bulk density of the waste material was very high, approximately 2.5 g/cc. Texture was a loamy sand to sandy loam, as confirmed by particle size analysis. Lead analysis in total digest and TCLP extracts was performed following SW-846 methodology and USEPA-approved QA/QC protocols.

Various test runs of the MAECTITE® treatment process revealed that the technology was successful in reducing leachable lead to levels below 5 mg/l by the TCLP test criterion. TCLP lead was reduced from 461 mg/l to 1 mg/l following 4 hours of curing, and waste volume reduced by 13 percent. Following 96 hours of curing and drying of treated material, waste volume decrease was measured at up to 29 percent. The optimum dosage of the treatment chemical was determined and recommended for full-scale treatment. This information was employed in developing a cost proposal for full-scale treatment recommendation in the RI/FS.



Treatability Study No. 9: Lead Dross in a Charcoal Carbon Matrix

Tool Manufacturing Facility (Confidential), Northeastern U.S.

Period of Performance: November - December 1992

Treatability studies were requested by the owner of a tool manufacturing facility where a large landfill and lagoon were undergoing RCRA closure.

A sample of charcoal carbon containing total lead in the range of 8.4 to 17.2 percent and TCLP lead in the range of 43.6 to 105.6 mg/l was collected for treatability study analysis. The lead was heavily concentrated in the dross chunks greater than 3/8 inches across (which comprised less than 5 percent of total waste).

Although the waste mass was highly heterogeneous, TCLP lead levels were reduced by the MAECTITE® process to below the regulatory compliance limit of 5 mg/l. All bench-scale and engineering-scale test runs of MAECTITE® and other treatment process technologies confirmed MAECTITE® to be the most feasible and cost-effective alternative in managing the lead-contaminated charcoal carbon waste generated at this facility.

A technical report and cost proposal for full-scale application were prepared on the basis of this treatability study.

Treatability Study No. 10:

Lead in Moist Foundry Sands

Gray Iron Foundry (Confidential), Michigan

Period of Performance: October - November 1992

During the application process for RCRA closure of a wastewater lagoon system at a gray-iron foundry, lead and cadmium were discovered in lagoon sediments. The owner requested that MAECTITE® treatability studies be conducted on the sediments.

The objective of this generic treatability study was to reduce TCLP lead in a solid waste from 221 mg/l to below 5 mg/l. Various treatment options were attempted, including MAECTITE®'s patent-inclusive Triple Super Phosphate (TSP). Standard MAECTITE®, however, was determined to be the most cost-effective treatment option. The MAECTITE® process reduced TCLP lead values to below 3 mg/l in treated material as a contract specified treatment objective.

From this bench-scale generic treatability study it was possible to define the optimum dosage of treatment chemicals needed for full-scale treatment. A bid and pricing proposal was developed based on the information accumulated during this treatability study, and the project was successfully completed at full scale for the client.



Treatability Study No. 11:

Lead-contaminated Soil (D008)

Traub Battery Superfund Site, Sioux Falls, South Dakota

Period of Performance: May - July 1992

Battery recycling operations and USEPA ERCS contractor response at this Superfund site had resulted in a stockpile of lead-contaminated soils in excess of 5,500 cy. Treatability studies were initiated at the site following bid approval under USEPA's Pre-Qualified Offers Procurement System (PQOPS).

A composite sample from the site was characterized, and the MAECTITE® process applied to achieve the following USEPA-specified performance standards:

- TCLP Lead (USEPA Method 1311) ≤ 5 mg/l
- MEP Lead (USEPA Method 1320) ≤ 5 mg/l (cumulative for all 10 MEP extractions)
- Volumetric Increase ≤ 50 percent

Performance standards were met at both bench and engineering scale. The information gathered was then employed in developing a bid package, a cost and technical proposal, a work plan, a quality assurance project plan, and a site health and safety plan.

In a soil sample containing an average of 0.7 percent total lead, application of the MAECTITE® treatment process reduced TCLP and MEP lead to below 1 mg/l. The optimum dosage of treatment chemical was identified during the bench-scale trials and recommended for scale-up activities.

At engineering scale, a volume decrease of 14 percent was measured after 24 hours of treatment; of 20 percent after 72 hours; and of 29 percent after 96 hours of treatment. The TCLP lead level in the treated sample was less than 0.2 mg/l and MEP lead was less than 0.5 mg/l.

The full-scale application of the MAECTITE® process saved USEPA approximately \$120,000 under the PQOPS contracting mechanism.

Refer to Full-Scale Project No. 10 for an implementation summary.

Treatability Study No. 12:

Lead-Contaminated Soil

Stout Battery Site, Muncie, Indiana

Period of Performance: June - July 1989

Bench-scale treatability studies were initiated in a mobile lab and carried out on site using the MAECTITE® treatment process. The treatment objective at this site was to reduce EP Tox lead to below 5 mg/l. An approved Quality Assurance Project Plan was followed for all sampling and testing. All applicable OSHA, USEPA, and USDOT health and safety regulations were followed.

Waste samples showed total lead ranging from 0.34 to 9.5 percent. EP Tox lead ranged from 50 to 520 mg/l, making the waste toxic by RCRA standards. The cation exchange capacity of the soils ranged from 12 me/100 g to 18.7 me/100 g. Organic matter varied from 3.4 to 5.1 percent.

Twelve (12) substances were tested for capacity to treat lead in wastes from this site, including cements, silicates, and pozzolans. Other techniques for treatment of lead in soil were also explored. These included:

- Washing lead-bearing soils with solutions of potassium chloride and/or ammonium acetate
- Treating lead-bearing soils with sulfide salt to form lead sulfide
- Oxidizing lead and its organic chelates in the soils with potassium permanganate and/or hydrogen peroxide

The accelerated treatability studies program featured a factorial approach to experimental design. The MAECTITE® process was identified as the most cost-effective approach to chemically fix the lead in site soils.

Following basic treatability studies, bench-scale studies were initiated. The purpose of these studies was: (1) to minimize the amount of treatment additives required; (2) to find optimal curing time; and (3) to define optimal moisture conditions for the process. Part of the bench-scale effort was directed toward testing the quality and effectiveness of treatment chemicals, in addition to establishing their availability and cost. Strict QA/QC procedures were observed during these studies, and 10 percent of samples tested were sent to an independent laboratory for confirmatory testing. Bench-scale treatability results were as follows:

TEST RUN	EP TOX LEAD (mg/l)	
	BEFORE TREATMENT	AFTER TREATMENT
I	46	<0.1
II	495	<0.1
III	3,659	1.7

In all instances, a loss of carbon dioxide from the breakdown of carbonates and bicarbonates was evident. This was associated with a corresponding reduction in waste volume of nearly 30 percent, and a decrease in mass.

Treatability Study No. 13: Lead Fixation in Wire Fluff Matrix

Telecommunications Company (Confidential), South East, Texas

Period of Performance: August - November 1993

Wire fluff is a waste product from telephone wire copper recovery operations. It consists of fibrous strands and particulates of insulation, paper, and jute lint. A wire fluff sample containing TCLP lead of 130 mg/l and total lead of 33,334 mg/kg was obtained by Severson to test the feasibility of using the MAECTITE® treatment process to fix the lead in the sample, and to evaluate the cost-effectiveness of a full-scale effort to render the waste non-hazardous using MAECTITE® technology.

Two treatment objectives were set: one, to achieve 5 mg/l lead concentration in the TCLP extract, and two, to achieve 1.5 mg/l lead in the TCLP extract. The latter was to meet the requirements of the local landfills approved to receive the treated special waste. The dosages of MAECTITE® treatment chemical needed to meet each of the two treatment levels, and associated costs (including transport and disposal costs), were compared for value engineering purposes. Meeting the treatment objective of 1.5 mg/l of TCLP lead was found to be the most cost-effective approach.

It was therefore decided to use the MAECTITE® treatment process to lower TCLP lead to below 1.5 mg/l. Based on the treatability study data, full-scale treatment costs were optimized and presented to the client. A detailed treatability report and a work plan for treatment of 5,000 cy of the material on site were prepared. The work plan was eventually approved by the state for implementation, the project was carried out, and the material disposed of as a non-hazardous special waste in an approved landfill.



Treatability Study No. 14: Lead Fixation in Chopped Wire Matrix

Confidential Copper Recovery Facility

Midwest United States

Period of Performance: Spring 1993

A representative sample of chopped wire piles was characterized for leachable lead by TCLP analysis (USEPA Method 1311) using USEPA SW-846 protocols. Test results on the untreated wire chop sample showed TCLP lead content from 23.0 mg/l to 28.8 mg/l. Total lead ranged from 0.31 to .51 percent. The density of the waste material was estimated at 0.4 tons/cy.

Bench-scale treatability studies were carried out using the MAECTITE[®] treatment process. The treatment objective was to reduce TCLP lead to levels below the regulatory threshold limit of 5 mg/l. The bench-scale test demonstrated that less than 1 percent by weight of MAEPRIC reagent was sufficient to lower TCLP lead levels to below 0.5 mg/l.

An engineering-scale treatability study was designed and executed to confirm and repeat the bench-scale results. The test in fact confirmed bench-scale results, indicating that the MAECTITE[®] process was effective in decreasing TCLP lead content from 27 mg/l to 0.2 mg/l. Curing time for the treated waste was approximately one-half hour.



FULL-SCALE APPLICATION



Full-Scale Application

The MAECTITE® treatment process has been applied to lead-contaminated wastes in 13 full-scale projects ranging from RCRA sites to Superfund cleanups. Volume of wastes treated has amounted to over 100,000 tons. Clients have included major industrial firms, PRP groups, and State and Federal agencies. Due to the greater process control possible with ex-situ treatment, ex-situ has been the most common mode of implementation, although in-situ treatment has been carried out at smaller sites.

Several cases where the MAECTITE® treatment process has been taken to full scale are summarized in the following pages. Project names and locations follow:

SITE NAME	LOCATION
Marathon Battery	Cold Spring, New York
Confidential Telecommunications Co.	South East, Texas
Confidential Metal Recovery Facility	Cleveland, Ohio
Stout Battery	Muncie, Indiana
Confidential Battery Manufacturer	Frankfort, Indiana
Lee Farm	Woodville, Wisconsin
Gratiot Iron & Steel	Ithaca, Michigan
RCRA Closure	Ohio
Confidential Superfund Site	Virginia
Traub Battery	Sioux Falls, South Dakota

Full-Scale Project No. 1: CERCLA Site Remediation for Cadmium- and Lead-Contaminated Soil, Sediments, and Marsh Material
Marathon Battery Site (Confidential), Cold Spring, New York
Period of Performance: 1993-1994 (ongoing)

This complex site consists of approximately 150,000 tons of soils, river and cove sediments, and cattail-marsh material, all contaminated with cadmium and lead. Procedures for extensive material excavation, dredging, dewatering, and handling were designed and executed within rigid site control measures.

Located along the tidally influenced Hudson River, the site is subject to widely fluctuating river levels. Impact of these conditions was controlled by the installation of expansive earthen dikes and a supplemental waterdam structure.

Cove, pond, and river sediments were dredged and dewatered for subsequent MAECTITE® treatment. Cattail-marsh material within the dike and dam structures was removed with flotation swamp excavators and dump vehicles specifically designed and fabricated by Severson for site conditions. Excavated material was air-dried and sized for treatment by the MAECTITE® process.

Soil from the former manufacturing facility was excavated and delivered to the MAECTITE® system for treatment along with previously accumulated river sediments.

Severson conducted extensive treatability studies prior to mobilization and during remediation to demonstrate, optimize, and control the MAECTITE® process. Two (2) MAECTITE® processing systems were operated on site to increase treatment production to an average of 1,000+ tons/day with production reaching as high as 1,600 tons/day. Treated material was allowed to cure for 3 to 5 hours prior to confirmatory sampling and analysis.



Dual rail spurs installed by Severson allowed for 10 - 20 gondola rail cars a day to economically transport treated material to a licensed (special waste) subtitle "D" landfill.

In the untreated material, total cadmium ranged up to 14.7 percent, with TCLP cadmium ranging up to almost 500 mg/l. Although TCLP lead was present above RCRA limits, it was co-treated with the cadmium to below the RCRA action limit. TCLP cadmium was reduced to well below 1.0 mg/l for treatment compliance. TCLP lead was reduced to below 5.0 mg/l.

Full-Scale Project No. 2: RCRA Corrective Action for

Lead-Contaminated Wire Cable Fluff

Telecommunications Company (Confidential), South East, Texas

Period of Performance: September - November 1993

The wire fluff at this site was a waste product from telephone wire copper recovery operations. It consisted of fibrous strands and particulates of insulation, paper, and jute lint. The material contained total lead up to 0.33 percent and TCLP lead ranging from 15.9 mg/l to 130 mg/l. The material was relatively light, with a density of about 0.3 tons/cy. The MAECTITE® treatment process, applied at bench- and engineering-scale, was seen to decrease TCLP lead to 1.5 mg/l, below the regulatory threshold limit. Achieving such a treatment objective at full scale would make it possible to comply with regulations for Texas Type II special waste landfills, reducing transport and disposal costs significantly.

Following the bench- and engineering-scale studies, a work plan was prepared for state approval. A MAECTITE® treatment system was mobilized and operating on site within a week of project commissioning. The project was carried out through a period of intense heat (95°F), with relative humidity exceeding 90 percent on a daily basis. Due to the nature of the material, extensive dust control practices had to be implemented, along with modified material handling procedures. The treated material was sampled daily and analyzed in the mobile laboratory. Severson's Sonication/Extraction test (which simulates TCLP in approximately 2 hours) was used to predict whether the treated material would pass or fail the treatment objective criterion of 1.5 mg/l. Each day a representative sample of the treated material was also sent to an independent laboratory for confirmatory testing.

The confirmatory TCLP lead results ranged from 0.17 mg/l to 1.46 mg/l for the 40 samples of treated material submitted. Data from the confirmatory analyses were checked for compliance with the Quality Assurance Project Plan (QAPjP), and all data were found to be valid. The data obtained in the mobile onsite laboratory were also found to be in full compliance with the QAPjP



and to exceed the requirements of QA Level II.

In accordance with approved plan and contract specifications, 2,000 tons of treated material (TCLP criterion < 1.5 mg/l) were transported and disposed of in an approved landfill over a one-month period. Soil beneath the wire fluff piles was also removed, treated, and disposed of as a non-hazardous waste.

Full-Scale Project No. 3: Stabilization of RCRA Waste Material

Metal Recovery Facility (Confidential), Cleveland, Ohio

Period of Performance: August - September 1993

Bench-scale treatability studies on material collected at this site demonstrated that the MAECTITE® treatment process rendered the lead-contaminated soil non-hazardous by RCRA definition (TCLP lead <5 mg/l). Based on the optimized dosage of MAECTITE® treatment chemicals, Severson developed a cost proposal to treat the hazardous soil (D008) on site. The untreated soil contained TCLP lead ranging from 38.3 mg/l to 99.6 mg/l and total lead ranging from 4,110 mg/kg to 28,475 mg/kg.

In engineering-scale treatment, the MAECTITE® process reduced the TCLP lead in soil from 99.6 mg/l in an untreated sample to 0.68 mg/l. No change in soil volume was evident as a result of MAECTITE® treatment. Based upon data from both bench- and engineering-scale tests, a remedial treatment work plan was prepared for approval by Ohio EPA.

Following Notice to Proceed, Severson mobilized all equipment, labor, and materials necessary to treat nearly 1,500 tons of contaminated material on site. In order to meet the remedial schedule, Severson used a 10 cy mobile Maxcrete mixer in a batch treatment configuration. MAECTITE® treatment chemicals were blended in an appropriate ratio by weight, then sufficient water was added for thorough blending, and wastes were transferred to curing and disposal containers. Care was exercised to ensure that end product maintained solidity in order to pass the Paint Filter test (USEPA Method 9095).

Treated material was disposed of as a non-hazardous special waste. The treated soil was subject to disposal analysis required by the RCRA-approved and licensed landfill. At the client's request, oversize debris was segregated for subsequent handling and disposal by the client. All executed activity complied with a State-entered Consent Order.



Full-Scale Project No. 4: Emergency Response and Initial Remedial Measures for Lead-Contaminated Soils

Stout Battery Site, Muncie, Indiana

Period of Performance: May - November 1989

Under an emergency response action at this site approximately 3,850 cy (5,000 tons) of contaminated waste was excavated, characterized, and subjected to the MAECTITE® treatment process. By reducing EP Tox lead levels to below the regulatory limit of 5 mg/l, the MAECTITE® process rendered the material non-hazardous. Lead oxide and lead oxide in soil resulted in total lead levels treated ranging up to 30 percent by weight. Efforts were initially made to reprocess the material at secondary smelters. Due to the presence of other contaminant metals, lead recovery was eliminated. A transportation and disposal permit was obtained from the Indiana Department of Environmental Management, the treated waste hauled off site for disposal, and the site backfilled with clean soil. Offsite properties that had been affected by lead migration from this site were also restored.

Full-Scale Project No. 5: Lead-Contaminated Solid Waste

Battery Manufacturer (Confidential), Frankfort, Indiana

Period of Performance: May - June 1990

The MAECTITE® process was applied to the following wastes at this site:

- Wastewater slurry from 10,000-gallon primary clarifier containing 3.1 percent total lead and 245.5 mg/l EP Tox lead
- Clarifier sludge in 387 drums with 2.9 percent total lead and 98.4 mg/l EP Tox lead
- Nearly 100 cy of waste cake with 2.86 percent total lead and 245.3 mg/l EP Tox lead

Treatment of this material with the MAECTITE® process reduced TCLP lead and EP Tox lead to levels below 1 mg/l, making it disposable in a licensed solid waste landfill as a nonhazardous special waste.



Full-Scale Project No. 6: Lead-Contaminated Soils

Lee Farm Superfund Site, Woodville, Wisconsin

Period of Performance: October 1990 - January 1991

Nearly 11,000 tons of lead-contaminated soil was treated by the MAECTITE® process at this upper Wisconsin site. Bench- and engineering-scale optimization data were used to design and set up a full-scale mobile MAECTITE® treatment system on site. A landfill cell was constructed with a thick clay bottom liner and a lysimeter system to monitor leachate flow from the treated soils.

Total lead content in the soil ranged from 2.03 to 3.55 percent. The MAECTITE® treatment process reduced TCLP lead in the treated soil from levels as high as 422.4 mg/l to as low as 0.7 mg/l. All soil treated by the MAECTITE® treatment process met the regulatory threshold value of 5 mg/l for TCLP lead, which was the treatment objective for this project. Treated material was disposed of as a non-hazardous special waste in an approved landfill cell constructed on site.

Full-Scale Project No. 7: Soils and Solid Wastes

Gratiot Iron and Metal Superfund Site, Ithaca, Michigan

Period of Performance: May - July 1991

Approximately 4,500 tons of lead-contaminated soils and solid waste materials with casing and lead battery components were treated at this site using the MAECTITE® treatment process. All personnel and equipment (including a mobile laboratory) were mobilized on site within one week of award of contract. The project remained on schedule, with an average production of 300 tons of treated waste per day. All treatment operations in the hot zone took place in Level C protective equipment. Air monitoring stations were installed upwind and downwind.

Every batch of waste material treated by the MAECTITE® process met the regulatory criterion of 5 mg/l for TCLP lead. This assessment was confirmed by an outside independent laboratory, to which samples were sent for confirmation under strict chain-of-custody procedures.



Full-Scale Project No. 8: **Lead-Contaminated Soils and Solid Wastes**
(RCRA Lagoon and Landfill Closure)

Tool Manufacturer (Confidential) Eastern Ohio

Period of Performance: August - October 1991

Lead-contaminated wastes at a 10-acre landfill in Ohio consisted of cinders from coal-fired boilers, spent coke, metal shavings, metal grindings, scrap metal, construction debris, crushed bricks, refractory bricks, trash, and soil. The site, owned by a 150-year-old tile manufacturing facility, was to be cleaned up and closed. TCLP lead in the waste ranged from 13.6 to 710.5 mg/l, and total lead from 1.35 to 2.28 percent. An extensive sampling effort indicated that lead concentrations were non-homogeneous over the site.

Following mobilization, including provision of a mobile laboratory, the site was excavated on a three-dimensional grid. Costs were significantly reduced by segregating characteristically hazardous material from non-hazardous material through a comprehensive grid sampling and analytical plan. As the contaminated material was removed, it was tested for TCLP lead and total lead. Material within the remedial target area that was not hazardous was excavated and directly disposed of as a non-hazardous material, leaving only 18,000 tons to be treated. This resulted in a cost saving to the client of several million dollars. Non-hazardous waste was immediately disposed of at an approved solid waste landfill. Hazardous waste was staged for MAECTITE® treatment.

The MAECTITE® treatment system was assembled on site for treatment of approximately 18,000 tons of lead-contaminated soils and solid wastes (D008). The system was set up to run continuously, with an average daily production of 300 tons of treated material. MAECTITE® treatment reduced TCLP lead to less than 5 mg/l, rendering it non-hazardous. [The treated samples were also sent to an independent laboratory for confirmatory analysis.] The treated material was transported and disposed of in a solid waste landfill.

Included in the 18,000 tons were approximately 1,000 tons of material that contained lead, reactive cyanide, and reactive sulfide. After comprehensive treatability demonstrations, Ohio EPA allowed full-scale treatment of this material with the MAECTITE® process after RCRA Closure Plan modification and approval. MAECTITE® treatment was successful for the reactive cyanide and sulfide.



Full-Scale Project No. 9: PRP-Funded Superfund Site Cleanup

Confidential Client, Eastern Virginia

Period of Performance: June - November 1992

The objectives of this project were: (1) to assess the extent of lead contamination at this site; (2) to excavate and separate hazardous waste from non-hazardous; and (3) to treat the hazardous waste with the MAECTITE® process, converting the lead-contaminated hazardous to a non-hazardous waste.

Only 20 tons of waste material was found to be hazardous by TCLP (up to 69 mg/l of TCLP lead). This material was treated on site with USEPA approval using the single-step MAECTITE® treatment process. After approximately 3 hours of curing, the treated material was sampled.

TCLP lead was found to have been reduced to less than 0.5 mg/l, a result that was confirmed by an independent CLP laboratory off site. The treated material was disposed of at an offsite, licensed landfill as a non-hazardous waste.

**Full-Scale Project No. 10: Remediation of Lead-Contaminated Stockpile of Waste and Soil
at a Superfund Site**

Traub Battery Site, Sioux Falls, South Dakota

Period of Performance: September - December 1992

Within one week of Notice to Proceed, the MAECTITE® treatment system was assembled and prepared to treat 400-600 tons of waste material per day - at this lead-contaminated Superfund site. Material to be treated amounted to nearly 4,000 tons of soil and waste.

The MAECTITE® process was used to render the 4,000 tons of soil and waste non-hazardous by RCRA definition. The treated material was sampled and split with the TAT team for analysis. For data verification and validation purposes, 10 percent of the samples were sent to an independent laboratory for TCLP lead and MEP lead analysis.

Almost all analytical results (MEP and TCLP) from all three laboratories showed less than 1 mg/l lead in the treated material. The treated material was disposed of as a non-hazardous special waste in a licensed landfill. This was the first Pre-Qualified Offers Procurement System (PQOPS) project authorized and funded by USEPA under its fixation/stabilization rapid contracting mechanism.



V. TREATABILITY STUDY PROCESS

TREATABILITY STUDY PROCESS

In order to properly assess the MAECTITE® process's capacity to effectively treat waste, Sevenson requires a treatability study to be conducted on waste samples. Several levels of evaluations are available.

Viability Study

- Demonstrates MAECTITE®'s capacity to render waste non-hazardous
- Often suitable for full-scale bid estimating
- Letter summarizing study result is the standard reporting mechanism

Bench-Scale Study

- Optimizes MAECTITE® process to representative site samples
- Typically satisfies regulatory agency, client, and consultant concerns regarding technology's capacity to effectively treat site material
- Utilizes USEPA QA Level II analytical procedures
- Allows for full-scale bid estimating
- Variety of reporting formats available

Engineering Scale Study

- Replicates optimized bench-scale MAECTITE® process results on enlarged sample quantity (> 2,000g)
- Further addresses client, consultant, and/or regulatory agency needs
- Variety of reporting formats available

Pilot-Scale Study

- Conducted on site with down-scaled processing equipment
- Useful for evaluating customized material handling methods for varied waste consistencies and characteristics

Often required for large-scale projects

Not recommended for small to mid-size project waste quantities due to cost-effectiveness considerations

Optimization at full-scale production level is preferred for such projects

In addition to treatability studies, site inspections and client discussions are employed to prepare full-scale remedial treatment work plans and formal price quotations.

Typically, Severson conducts viability and bench-scale studies approximately 1-3 weeks after site samples and the Treatability Study Request Form (Section VIII) are submitted. All treatability studies are conducted by WasteStream Technology, Inc. (a wholly-owned subsidiary of Severson), in Buffalo, New York. Technical oversight is provided by Severson's co-inventors of the MAECTITE® technology, with site operational input available from experienced project managers and other Severson field personnel.

Severson can also use its mobile laboratory fleet for onsite treatability study support at both pilot demonstration and full-scale remediation projects.



VI. PRICING

General

The MAECTITE® treatment process for lead-contaminated soil and solid waste has proven to be a cost-effective process that not only brings TCLP lead into conformance with USEPA land disposal requirements, but may also reduce waste volume by 15 percent or greater, depending upon material-specific characteristics.

Pricing of this technology is consistently applied to site/waste stream operational phases in a manner outlined in this document. Process application may have both lump-sum and unit price elements. Lump-sum prices typically cover minimum site and process needs. Unit prices are used when production depends upon variable factors, such as waste characteristics, volume of material encountered, and duration of the project. Both types of pricing can appear in the cost proposal for a given site, depending upon client specifications.

The following list identifies typical primary cost-component phases of the MAECTITE® treatment process when applied to a remedial project that is taken from sampling through full-scale production:

<u>Phase</u>	<u>Lump Sum</u>		<u>Unit Price</u>
Sampling	✓		
Treatability Study	✓	or	✓
Preparation	✓		
Mobilization	✓		
Setup	✓		
Optimization	✓		
Full-Scale Treatment	✓	or	✓
Decon and Teardown	✓		

<u>Phase</u>	<u>Lump Sum</u>	<u>Unit Price</u>
Demobilization	✓	
Reporting	✓	

The following discussions by primary project cost-component phase provide a brief summary of the types of work to be performed, resources typically needed, and estimated duration of activity.

Due to the variety of federal and state requirements that may have to be met for treatment permitting, permitting has not been treated as a cost-component phase in this document.

Full-Scale treatment cost ranges are discussed at the end of the section.

Sampling

Collection of samples for treatability testing and engineering-scale treatment process optimization by Severson may be completed by the client or by Severson. Pricing for full-scale treatment will be based in part upon the character of samples collected. Range of variability in the material can be specified as part of the scope of work.

Sampling efforts may require the use of a drill rig to collect both representative and worst-case samples.

While surveys to determine extent of contamination and confirmation of cleanup must be completed as part of the overall project, the purpose of sampling is not to determine the extent of contamination but to generate material for the testing of parameters that affect and limit the MAECTITE® treatment process.

To accomplish waste characterization and treatability objectives, Severson requires at least one



5-gallon container of material for each identified waste stream. Collection of worst-case material is also recommended.

Sampling efforts normally require only one day, but up to 5 days may be required for large or complex sites. Resources needed to complete the sampling effort generally consist of a field geologist, a technician, and the appropriate sampling equipment.

This activity is most often conducted by the client or by the investigation project consultant.

Treatability Study (See Also Section V)

The purpose of the treatability study is to verify that the MAECTITE® treatment process is technically and economically feasible for the chemical treatment of leachable metals in soil and solid waste at the targeted site. A further purpose is to provide bench- and engineering-scale data that optimize the treatment chemical and waste-matrix amendments needed to satisfy treatment objectives. The end products of the study will be a report and, if appropriate, a proposal (technical and cost) to conduct full-scale treatment on site.

Once samples have been received by Sevenson, sampled material will be analyzed for parameters that characterize the waste. Parameters of interest may include total and TCLP lead, pH, percent saturation moisture, cation exchange capacity, redox potential, alkalinity/acidity, particle grain size, specific gravity, percent organic matter, or other landban-related parameters. Final parameters to be measured will be determined after site histories have been evaluated.

Based upon this information, the final treatability study design will be completed and executed. Various bench-scale treatment scenarios will be examined, with the end products analyzed by Sevenson's in-house treatability laboratory according to approved USEPA methodology. Samples from a successful treatment scheme that appear to represent the most economical full-scale approach will then be sent to an independent laboratory for confirmational testing.

Upon receipt of confirmational test results, the process will be optimized on an engineering-scale batch of material. Severson's laboratory will again identify the optimal treatment chemical dosages. Confirmatory samples will again be sent to the independent laboratory for analysis to verify compliance with treatment objectives.

A final treatability report will be prepared presenting the findings and recommendations of the study.

If full-scale treatment appears feasible, all analytical data, site-specific information, and input from Severson's field operations will be assembled, evaluated, and used to generate a technical and cost proposal for full-scale application. This document, based upon the representative samples received for the treatability study, will be submitted under separate cover.

Resources to complete the treatability study phase include a senior scientist, a chemist, a laboratory technician, Severson's fully equipped treatability laboratory, and an independent subcontract laboratory. Duration of the treatability study is typically 2 to 4 weeks, depending upon waste matrix interferences and client needs.

Samples shipped to Severson must be accompanied by completed sample tracking and chain-of-custody forms. [See Section VIII - Forms).

Preparation

The preparation phase of this process is the first operational step towards full-scale treatment. It involves the procurement of treatment chemicals and other site-specific materials, equipment readiness and modifications, detailed project scheduling, and medical baseline testing of the field crew for blood lead. All project pre-site-coordination activity is completed during this phase, including communications with the client and regulatory agencies as required (exclusive of



permitting).

Resources committed to this phase of the project include a senior scientist, a project manager, and a superintendent. The duration of this phase is 2 to 3 weeks.

Note: Preparation may also include site work as needed to ready the targeted material on site for treatment. Grading, excavation, staging of material, and additional field analysis may be required prior to mobilization for treatment.

Mobilization

The mobilization phase of the project includes delivery to the site of all site support equipment and instrumentation, treatment equipment, decontamination facilities, and assigned field personnel.

In the event that site preparation is required prior to treatment (e.g., for material excavation and staging), treatment system mobilization will not proceed until the site is adequately prepared.

Mobilization is generally priced on a lump-sum basis.

Setup

In this phase of the project site support units are erected, the treatment system is installed, and the mobile laboratory is set up. This phase is completed when the entire site is ready for process optimization. All treatment equipment will have been installed and made operational for material throughput. The mobile laboratory will have successfully completed the analysis of USEPA samples for quality assurance/quality control (QA/QC) compliance, and will be ready

to commence testing for treatability and confirmation of treatment.

The duration of this phase is approximately 7 days. Severson resources dedicated to the setup phase are presented in the Full-Scale Treatment section of this document. Phase-specific resources may include an electrician, site grading equipment, a small crane, work area base material (road aggregate, etc.), and two to three cleanup technicians (in addition to those specified under Full-Scale Treatment).

Optimization

The optimization phase is the period where the first material is passed through the treatment system. Material handling patterns, monitoring instrumentation, equipment synchronization, and treatment chemical application methods are optimized. This phase is required to shake down the system and to make adjustments as necessary to ensure that the process is ready for full-scale operation.

Severson technicians will conduct testing in the mobile lab to monitor compliance with treatment objectives. The laboratory will also evaluate waste material to be treated in advance of actual full-scale processing. Due to the 18-hour leaching period needed for TCLP analysis, a 3-day lead time is required. The intent of the laboratory work is to complete scaled treatment and confirmatory testing of material to be treated at full-scale prior to actual startup of the treatment system.

This phase lasts approximately 3 days. Resources typically dedicated to this phase are presented in the Full-Scale Treatment section of this document. Experience has shown that the Optimization phase is preferable to onsite pilot-scale demonstration.



Full-Scale Treatment

Full-scale treatment of targeted material is initiated upon completion of the optimization phase. The duration of this phase is dependent upon the volume of material to be treated, the production rate of the treatment system, site-specific conditions, waste matrix complexities, and prevailing weather conditions. All these factors will have been considered in the proposal preparation phase.

Typically, the treatment system is capable of processing from 150 to 1,600 tons of material per day, with an average of 1,200 tons per day on a 150,000-ton site. This production rate is based upon a 12-hour workday.

Labor resources may include:

Support (off site, intermittent)	Senior scientist
	Health and safety officer
	QA/QC coordinator
	Equipment and supply manager
	Shop technician
Support (on site, one each)	Project manager
	Project control specialist
	Project chemist
	Chemist
	Laboratory technician
	Mechanic
	Support technician
Treatment operation	Technical treatment foreman (1)

Equipment operators (4)

Cleanup technicians (5)

Labor resources dedicated to the treatment phase (and to other phases as previously described) would likely include:

Support (on site)

Office trailer (1-2)

Equipped mobile treatment and analytical laboratory

Decontamination trailer and corridor components

Personnel vehicles (2 - sedan & pickup)

Computers (2 - office trailer & lab)

Treatment

Hydraulic excavator

Bobcat

Bulldozer

Front-end loaders (2)

Personnel vehicles (3 - utilivan, passenger van, pickup)

Chemical silo with variable-speed delivery units (3)

Chemical tank farm (4 poly storage tanks)

Soil conveyors (2-4)

Waste sizing/screening and blending train

Electrical control panels, conduit, and wiring

Makeup water system and manifold

Water storage tank (1)

Flowmeter

Fuel tanks

Pressure washer

Scales or weighbelt feed system

Security and site lighting



Miscellaneous pumps, hoses, and fittings
Miscellaneous hand and specialized tools

Material and subcontractor resources required to complete treatment objectives may include:

MAECTITE® powder with freight
MAEPRIC solution with freight
Equipment fuel
Expendable laboratory supplies
Laboratory and survey services
Personal protective equipment
Spare parts

These lists are partial. Winterization elements, for example, have not been included. It is assumed that a source for treatment chemical makeup water and electric power is available.

Resources may vary depending upon whether the material is to be treated in situ or ex situ; to remain on site or to be transported and disposed of off site. Resources are also dependent upon quantity of material for treatment, site characteristics, available space, and production requirements. Site-specific approaches will be discussed in the technical and cost proposals.

Decontamination and Teardown

Decontamination and site teardown commence upon completion of all material treatment and receipt of necessary confirmatory sample results. Resources dedicated to this phase are similar to those presented in the Full-Scale Treatment section. Duration of this phase is typically 3 to 5 days, depending upon site conditions and weather.

Demobilization

The demobilization phase includes the removal from the site of all equipment, instrumentation, decontamination facilities, and personnel.

Demobilization is generally priced on a lump-sum basis.

Project Reporting

Reporting is addressed throughout the project. Frequency, types, and recipients of submittals are usually identified during proposal preparation.

Upon completion of all site activity, Severson will prepare a final report presenting all data generated over the course of the project. This report will include: an executive summary; discussion of methods; presentation of generated data and findings; chronology of events; summary of activities; and tables, figures, and drawings as needed. The duration of the final report preparation is a function of project size and complexity.

Full-Scale Treatment Cost Ranges

Although total site costs vary greatly with site characteristics, geographic location, work plan specifics, client requirements, and regulatory agency criteria, Severson has found that per ton treatment costs have ranged from as low as \$20/ton to approximately \$75/ton. Waste matrix, volume of material for treatment/economies of scale, contaminant source and form, treatment objectives, and material "handleability" can all affect production efficiency and processing cost.

5

VII. REFERENCES



FOR BENCH- AND ENGINEERING-SCALE STUDIES

PROJECT	CONTACT	ADDRESS	TELEPHONE
RCRA Surface Impoundment Closure	Bob Einhaus, PhD Environmental Director	Group Dekko International, Inc. 11913 E-450 South La Otto, IN 46763	219-637-3964
Lead Battery Soil Corrective Action	Mr. Doug Bowe Project Manager	TERRADON Corporation P.O. Box 519 Nitro, WV 25143	304-755-8291
Lead Battery Soils Completed Emergency Removal	Mr. Loren Camp, P.E. County Engineer	Muskingum County 155 Rehl Road Zanesville, OH 43701	614-454-0155
Marathon Battery Various Sediment Soils, and Debris	Ms. Barbara Forslund, P.E.	Advanced GeoServices Corp. Brandywine Two - Suite 305 Chadds Ford, PA 19317	215-558-3300
D008 Waste Water Treatment Sludge	Mr. Donald Pfeiffer Environmental Manager	Thomson Consumer Electronics P.O. Box 2001 Marion, IN 46953	317-662-5553

FOR FULL-SCALE PROJECTS

PROJECT	CONTACT	ADDRESS	TELEPHONE
Muskingum County Removal Action	Mr. Loren Camp, P.E. County Engineer	Muskingum County 155 Rehl Road Zanesvill, OH 43701	614-454-0155
Stout Battery Site Removal Action	Ms. Susan Wyss Former PM IN Dept. of Env. Mgmt.	W.W. Engineering 5010 Stone Mill Road Bloomington, IN 47408	821-336-9725
Lee's Farm Site Woodville, WI	Mr. Bob Bowden Chief USEPA Superfund Program Region V	USEPA Superfund Program 77 W. Jackson Street Chicago, IL 60604	312-353-2102
Gratiot Iron and Metal Site Ithaca, MI	Mr. Bob Bowden Chief USEPA Superfund Program Region V	USEPA Superfund Program 77 W. Jackson Street Chicago, IL 60604	312-353-2102
	Mr. Jason El-Zain On Scene Coordinator USEPA Region V	USEPA REGION V Response Section I 9311 Grote Road Grosse Point, MI 48138	313-692-7686
Traub Battery Site Sioux Falls, SD	Mr. R.D. Medlin, PQOPS Programs USEPA, Washington, DC Contracting Officer	USEPA 401 M. Street SW Washington, DC Mail Code PM-214-E	202-260-3205
	Mr. Steve Hawthorne On Scene Coordinator USEPA Region V	USEPA REGION V 999 18th Street Suite 500 Denver, CO 80202-2644 Mail Code 8H WM-ER	303-293-1723 303-293-1224



VIII. FORMS



Waste Stream Technology Inc.

302 Grote Street
Buffalo, N.Y. 14207-2496
Phone 716-876-6290
FAX 716-876-2412

TREATABILITY SERVICES REQUEST FORM

Request Taken By: _____ Date Requested _____

Client _____ Telephone _____

Client Contact _____ Fax _____

Address _____

DOT Shipping Name _____ EPA Hazard Class _____

Consulting Engineers _____ Project Estimator _____

Source of Waste _____

Client/State/Federal Cleanup Criteria _____

Deliverables (circle one) Telephone _____ Facsimile _____ Written Report _____

Requested Completion Date _____ Bill To/PO _____

Attach Any Available Laboratory Data

Site Name	Sample Location	Matrix (Liquid, Soil, Sludge)	Treatment Method	Analytical Parameters

Sample Size Not to Exceed 2.5 Kilograms

Return Sample To:

Name _____ Company _____

Address _____

City/State _____ Zip Code _____

EPA I.D. Number _____

Additional Instructions _____



CHAIN OF CUSTODY RECORD

Distribution: Original accompanies shipment. Copy to coordinator field files.